4-29-99

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

MEMORANDUM

April 29, 1999

SUBJECT: HED's Review of "*Exposure to Chlorpyrifos While Applying a Ready to Use Formulation.*" MRID 44739301. DP Barcode: D252733. Case No. 818975. Submission: S555682. PC Code: 059101.

FROM: Deborah Smegal, M.P.H./Risk Assessor
Re-Registration Branch 3
Health Effects Division (7509C)
Office of Pesticide Programs

THRU: Steve Knizner, Branch Senior Scientist
Re-Registration Branch 3
Health Effects Division (7509C)
Office of Pesticide Programs

TO: Mark Hartman
Special Review and Reregistration Division (7508C)
Office of Pesticide Programs

Attached is a review of a study (44739301) by Versar, Inc., under the supervision of HED. It has undergone secondary review and has been revised to reflect Agency policies. HED has recalculated the chlorpyrifos dermal exposure estimates using a dermal absorption factor of 3% based on the recommendation of the Hazard Identification Assessment Review Committee (HIARC) in the March 4, 1999 report.

Conclusions

This study characterizes exposures to homeowners during the 1 hour application of approximately 0.5% Ortho Ant Stop (a ready to use formulation) to the outside foundation and perimeter of the house, and other areas (e.g., flower beds) where ants were present. A total of fifteen adult volunteers (nine females and six males) in the area of Indianapolis, Indiana were evaluated. The volunteers wore standard clothing that consisted of a short-sleeve coveralls with long pants, underwear, and a baseball style hat, but no gloves. Volunteers wore their own

uncontaminated shoes. Each volunteer was instructed not to treat their homes or yards with chlorpyrifos containing products either immediately before, during or after the conduct of the study, and to avoid chlorpyrifos-containing products 10 days prior and 4 days after application. The amount of active ingredient (ai) handled per replicate ranged from 0.015 g to 0.038 g (mean = 0.033 g; S.D. = 0.006 g).

Exposures were estimated based on both dosimetry measurements and biomonitoring of urinary 3,5,6-TCP (the primary metabolite of chlorpyrifos). Dermal exposure was quantified using passive dosimetry [cotton underwear (T-shirt, briefs or women's underwear), short-sleeve cotton coveralls with long pant legs, and hand washes; and a baseball style hat]. (The study did not mention socks). Inhalation exposure was measured using a personal air pump attached to the test subject's belt. The pump was connected by tygon tubing with a 37-mm mixed cellulose ester filter (0.8-μm pore size) connected to a Chromosorb 102 vapor collection tube to evaluate inhalation exposures in the breathing zone of volunteers.

Table 3 summarizes the total absorbed doses of chlorpyrifos via inhalation and dermal exposures, estimated from passive dosimetry and biomonitoring that should be used in the risk assessment. The total absorbed doses estimated from dosimetry range from 0.03 to 0.86 μg/kg BW, with a mean of 0.25±0.25 μg/kg BW. Approximately 12 percent of the absorbed doses resulted from inhalation (mean 0.03 μg/kg) and 88 percent from dermal exposure (0.23 μg/kg). The total absorbed doses estimated from biomonitoring ranged from 0 to 1.9 μg/kg BW, with an arithmetic mean of 0.49 ± 0.59 μg/kg BW, and a geometric mean of 0.24 μg/kg BW. The mean values are in somewhat good agreement with the estimates from dosimetry. The biomonitoring results are slightly higher, but given that hand wash residues contribute on average 57% of the total dermal exposure, it is possible that the volunteers may have incidentally ingested chlorpyrifos as well (which would only be captured in the biomonitoring results). As shown on Table 3, baseline chlorpyrifos exposure ranged from 0.05 to 0.3 μg/kg with a mean of 0.12 μg/kg, despite the fact that volunteers were instructed to avoid chlorpyrifos exposure 10 days prior to the study initiation.

This study met most of the requirements contained in the Series 875 Group A, Applicator Exposure Monitoring Test Guidelines, and the data are useful for risk assessment.

An Exposure Study - Exposure To Chlorpyrifos While Applying A Ready To Use Formulation (MRID # 447393-01) was submitted in support of the Re-registration requirements for the pesticide chlorpyrifos. The requirements for this study were specified by the U.S. Environmental Protection Agency (EPA) under OPPTS Series 875 Group B (Occupational and Residential Exposure Test Guidelines) of the Pesticide Assessment Guidelines. This study's identifying information is presented below.

Title:	Exposure To Chlorpyrifos While Applying A Ready To Use Formulation (MRID # 447393-01)
Sponsor:	Dow AgroSciences LLC
Performing Laboratory:	Global Environmental Chemistry Laboratory - Indianapolis Lab Dow AgroSciences LLC 9330 Zionsville Road Indianapolis, Indiana 46268-1054
Analytical Laboratory	Global Environmental Chemistry Laboratory - Indianapolis Lab Dow AgroSciences LLC 9330 Zionsville Road Indianapolis, Indiana 46268-1054
Authors:	D. E. Barnekow, W. L. Cook, T. J. Meitl, and B. A. Shurdut
Report Dates:	January 14, 1999
Identifying Codes:	MRID #447393-01, HEA 97046

EXECUTIVE SUMMARY

Chlorpyrifos is an insecticide widely used in agricultural and residential areas. This study was designed to estimate the total exposure to a person making a single outside perimeter application of a ready-to-use product containing approximately 0.5% chlorpyrifos.

Ortho Ant Stop containing 0.489 percent of active ingredient (ai) was used in the study. It was packaged as a 24 oz. ready-to-use disposable bottle with a screw on top. Application of five bottles of Ortho Ant Stop were made at each of 15 houses in the Indianapolis, Indiana area. Fifteen adult volunteers (nine females and six males) applied the ready to use product for one hour or until five containers were used, whichever came first. The volunteers wore standard clothing that consisted of a short-sleeve coveralls with long pants, underwear, and a baseball style hat, but no gloves. Volunteers wore their own uncontaminated shoes. Exterior treatments were made to home perimeters as well as some spot treatment of infested areas of the lawn. The application was not intended to treat a minimum area. Following application, the volunteers were instructed to avoid the treated areas until the end of the biomonitoring phase of the study was completed. In addition, each volunteer was instructed not to treat their homes or yards with chlorpyrifos containing products either immediately before, during or after the conduct of the study, and to avoid chlorpyrifos-containing products 10 days prior and 4 days after application. The amount of active ingredient (ai) handled per replicate ranged from 0.015 g to 0.038 g (mean = 0.033 g; S.D. = 0.006 g).

The potential dermal and inhalation exposures to chlorpyrifos during application were monitored using a combination of passive dosimetry and personal air sampling pumps. Total absorbed dose was also estimated by biomonitoring of the primary chlorpyrifos metabolite, 3,5,6-trichloro-2-pyridinol (3,5,6-TCP) in urine samples of the applicators. Dermal exposure was measured by means of supplied clothing consisting of underwear, short sleeve T-shirts, baseball style hat, and short sleeve coveralls. The coverall and undergarments were sectioned and analyzed to estimate exposures to arms, leg and torso regions. Head and neck exposures were measured using two 10 x 10 cm cotton denim patches attached to the front and back of the hat. Hand washes taken after each bottle of ready to use product had been applied, up to the first three bottles, and then after the fifth bottle. If a fifth bottle was not used, hand washes were done after each bottle was applied.

Inhalation exposure was measured using a personal air pump (SKC low volume pump) connected by tygon tubing with a 37-mm mixed cellulose ester filter (0.8-μm pore size) connected to a chromosorb 102 tube (66-mg front section, 33-mg back section).The air flow rate of approximately 1.5 liters per minute was calibrated before and after the sampling period. The chlorpyrifos trapped in the filter and the Chromosorb tube were extracted and analyzed using GC. The amount of chlorpyrifos found was divided by the volume of air sampled to give a time weighted air concentration. The potential inhalation dose was estimated based on this time averaged concentration, an inhalation rate of 1 m^3/hour for light activity, and the duration of insecticide application.

Total absorbed dose was also estimated directly by biomonitoring of the chlorpyrifos metabolite 3,5,6-TCP in the urine samples of applicators to confirm the absorbed dose estimated

from the dosimetry data. Each applicator collected all the urine voided on the day before application, the day of application, and for four consecutive days after initial exposure. The urine was collected at 12-hour intervals. A total of 12 urine samples were collected for each applicator. The urine samples were analyzed for 3,5,6-TCP using gas chromatography to estimate the total absorbed dose of chlorpyrifos.

Field recovery and storage stability data were collected. Recoveries were reported greater than 84 percent.

Total potential dermal dose was estimated by summing residue levels in torso, arms, head and neck, and the leg coveralls times the penetration factor. Estimated total dose of chlorpyrifos dermally absorbed based on passive dosimetry ranged from 0.03 to 0.86 μg/kg BW, with a mean of 0.25±0.25 μg/kg BW. The absorbed dose of chlorpyrifos derived from biomonitoring of urine samples for 3,5,6-trichloro-2-pyridinol (3,5,6-TCP), a metabolite of chlorpyrifos. The calculated dose for the 15 test subjects ranged from 0 (less than background) to 1.9 μg/kg BW, with a mean of 0.49 ± 0.59 μg/kg BW.

Based on the review by Versar, most of the requirements contained in Series 875 Group A of the Pesticide Assessment Guidelines were met in this exposure study with a few minor issues noted.

Study Background

Chlorpyrifos is an insecticide used widely for both agricultural and residential applications. Exposure information is available for most uses. However, little information is available for homeowners applying ready to use formulations for home insect control. This study was designed to estimate total exposure to a person making a single application to the perimeter of a home while applying a ready to use formulation.

Test Site

The test site consisted of fifteen residential homes in the area in and around Indianapolis, Indiana.

Materials, Application, and Sampling

Ortho Ant Stop Ant Killer in 24-oz. containers were used in this study. This is a ready to use formulation that requires no mixing or other preparation prior to use. The concentration of chlorpyrifos in the product was reported as 0.489 percent in a water-based dilution. Fifteen adult volunteers (nine females and six males) between the ages of 27 and 45 years applied the ready to use product for one hour, or until five containers were used, whichever came first. The study was not designed to treat a specific area. Following application, the volunteers were instructed to avoid the treated areas until the end of the biomonitoring phase of the study was completed. Each volunteer was instructed not to treat their homes or yards with chlorpyrifos containing products either immediately before, during or after the conduct of the study.

Dermal exposure was measured by means of: supplied clothing consisting of women's cotton underwear or short sleeve cotton T-shirts and briefs for men, a baseball style hat, and short sleeve coveralls. Volunteers wore their own uncontaminated shoes. Head and neck exposure was measured using two 10 x 10 cotton denim patches attached to the front and back of the hat. Exposure to the forearms was determined using a 2.5 cm wide arm band around each forearm. Exposure to chlorpyrifos which penetrated the outer clothing was determined from levels found on cotton T-shirts and briefs worn under the coveralls. Hand washes taken after each bottle of ready to use product had been applied, up to the first three bottles, and then after the fifth bottle. If a fifth bottle was not used, hand washes were done after each bottle applied. The hand washing solution was conducted with 250-mL of 0.008 percent Emcol 4500 soap solution applied in three parts. This was followed by rinsing with an equivalent amount of clean water. The wash and rinse were collected and combined in a stainless steel pan and transferred to a 32-oz. jar containing 15 grams of sodium chloride. The wash solution was extracted by shaking for one minute with 100-mL of isooctane.

Prior to application, site air monitoring was conducted for one hour to determine if background residue levels would interfere with the study results to verify there was no prior treatment with chlorpyrifos. Inhalation exposure was measured using a personal air pump (SKC low volume pump) connected by tygon tubing with a 37-mm mixed cellulose ester filter (0.8-μm pore size) connected to a chromosorb 102 tube (66-mg front section, 33-mg back section). The fiber filter was used to collect particulate matter. Each volunteer was fitted for two air monitoring devices. The devices were attached to the collar of the volunteers' clothing, in the

breathing zone. The air flow rate was approximately 1.5 liters per minute and was calibrated before and after the sampling period.

Biomonitoring was conducted by the collection of composite urine samples taken for 12 hour time periods. Urine was collected before the day of application, the day of application, and for each of four days following application. The urine was collected in brown plastic jugs. These jugs were kept on blue ice until the samples were weighed and aliquots collected. Two 10 mL aliquots were collected from each 12-hour sample. These aliquots were stored frozen. Urine were analyzed for creatinine and 3,5,6-trichloro-2-pyridinol (3.5,6-TCP). Volunteers were asked to avoid chlorpyrifos-containing products 10 days prior to and 4 days after application, which the urine was collected.

Clothing/Protective Clothing

The work clothing consisted of women's underwear or a short sleeve T-shirt and briefs for men, baseball type hat, and a short sleeve pair of coveralls, and 2.5 cm wide cotton denim armbands. Uncontaminated shoes, provided by the volunteers, were also worn.

Treatment Information

The amount of product applied varied by individual volunteer, ranging from 2 to 5 24 ounce containers. Table 1 summarizes the amount of Ant Stop Ant Killer handled per replicate. Application was made to the foundation and perimeter of the house and to any other areas (e.g., flower beds) where ants were present.

Sample Storage and Handling

After sampling, the air sampling media, cassettes, and chromosorb tubes, were placed into 8-oz. glass jars and placed on dry ice for shipment. The coveralls were sectioned into parts to represent legs, front torso, and rear torso before they were placed into one-gallon glass jars and placed on dry ice for shipment. Front t-shirt and front of briefs were combined to form one sample as were the corresponding back sections, which were stored in ½ gallon glass jars. All samples were stored frozen and shipped with dry ice to the laboratory for analysis. Two 5-mL aliquots of the isooctane extract from each hand wash sample were placed in glass vials and stored at freezer temperatures until analyzed. For biomonitoring, two 10 mL aliquots were collected from each 12-hour urine sample. These aliquots were stored frozen until analysis.

QA/QC

Method Validation

The report references method validation studies (pages 30 to 32 of the study report). However, the referenced reports are not included in the study.

Field Recovery

A total of five field recovery samples (weathered samples), fortified at the field site, were collected for the sampling matrices including whole body dosimeters (inner and outer),

chromosorb tube, and glass fiber filters. The filters and tubes were fortified with 0.5 μg of chlorpyrifos in 10 μL of isooctane using a 10 μL syringe. The coveralls and T-shirt sections were fortified with 2.0 mL of Ant-Stop formulation using a glass syringe. Field recovery samples were handled in the same manner as the field samples. Field recovery samples are not presented for head patches.

Storage Stability

Storage stability samples for coveralls and underwear only were fortified at the field site and were stored to cover the length of time from sample collection to sample analysis. No storage stability samples were prepared for filters and tubes and handwash solutions because of the short storage period.

Laboratory Recovery

Two laboratory recovery samples for all matrices for each sample set were fortified just prior to analysis of each sample set.

Data Summary

Field Recovery

Results for the field recovery are summarized in Table 4 through 8 of the original study report. Mean recovery for filters was 97.8±7.9 percent, for chromosorb tube was 97.9±5.9 percent, for coveralls was 99.1±4.7 percent, for underwear was 95.8±5.9 percent, and for handwashes was 93.6±5.1 percent. Field samples concentrations were corrected for field recoveries. Field recovery sample results were corrected for laboratory recoveries. Recoveries indicate that little chlorpyrifos was lost while the samples were exposed to the environment.

Storage Stability

Mean storage stability recovery levels for coveralls and underwear were 101 ±2.6 percent and 98.8±7.2 percent, respectively. Storage stability samples were corrected for laboratory recoveries. Recoveries indicate that little chlorpyrifos was lost during storage.

Laboratory Recovery

Mean laboratory recoveries ranged from 85.8 to 107.6 percent. All recoveries were greater than 84 percent, indicating an acceptable result. Mean recovery for filters was 105.1±5.8 percent, for chromosorb tube was 99.6±7 percent, for coveralls was 94.3±5.1 percent, for underwear was 85.8±8.3 percent, and for handwashes was 107.6±3.9 percent.

Exposure and Dose

Estimated exposures and dose concentrations of each test subject to chlorpyrifos are presented in Tables 1, 2 and 3.

Total potential dermal dose was calculated by combining residue levels in torso, arms (calculated from amount found on forearm bands), head and neck (calculated from amount found on hat patches), hands and the legs (calculated from coveralls times the penetration factor). A dermal absorption factor of 3 percent was assumed. Estimated amount of chlorpyrifos dermally absorbed ranged from 1.65 to 76.5 μg among replicates. Estimated total dermal dose (μg/kg BW) was calculated by dividing the estimated amount of chlorpyrifos dermally absorbed by participants body weight. As shown on Table 2, the estimated total absorbed dermal dose measured by passive dosimetry ranged from 0.03 to 0.84 μg/kg BW, with a mean of 0.22 ± 0.24 μg/kg BW (88 percent of estimated total dose). Head and neck exposure was calculated assuming surface area of the head and neck as 1,560 cm^2 (1,300 cm^2 for head exposure and 260 cm^2 for neck front and back exposure). A forearm surface area of 1,210 cm^2 was assumed.

Inhalation unit exposure was calculated by multiplying air concentration of chlorpyrifos by standard breathing rate of 1 m^3 per hour (for light activity recommended by USEPA Exposure Factors Handbook 1997) and the duration of insecticide application. As shown on Table 1, the inhalation exposures were calculated in μg/kg BW and ranged from 0.004 to 0.055 μg/kg BW (mean 0.03 μg/kg BW ± 0.01 μg/kg BW).

Biomonitoring data was used to calculate the absorbed dose of chlorpyrifos by analyzing urine samples for 3,5,6-trichloro-2-pyridinol (3,5,6-TCP) which is a metabolite of chlorpyrifos. Residues were corrected for any losses during storage and shipment by using storage stability recovery values. The urine samples were also normalized using individual mean creatinine output over the 6-day monitoring period. Exposure was calculated by dividing the total 3,5,6 TCP excreted in the urine in μg/kg BW by the product of the fraction of oral dose expected to be excreted in the five day monitoring period (0.6124), based on a pharmacokinetic model developed by Dow AgroSciences (Nolan et al. 1984) (See Appendix A) and the molecular weight ratio of chlorpyrifos to 3,5,6-TCP (350.6/198). The calculated dose for the 15 test subjects ranged from less than background to 1.9 μg/kg BW with an arithmetic mean of 0.49 μg/kg BW ± 0.59 μg/kg BW, and a geometric mean of 0.24 μg/kg BW. As shown on Table 3, the baseline exposure to chlorpyrifos ranged from 0.05 to 0.3 μg/kg BW with a mean of 0.12 μg/kg BW.

Review Summary

Compliance with OPPTS Series 875 Group A (Applicator Exposure Monitoring Test Guidelines) of the Pesticide Assessment Guidelines (U.S. EPA, 1998) is crucial for determining whether a study is acceptable to the Agency. The itemized list below is based on the "Checklist for Applicator Monitoring Data" and summarizes the major points of Series 875 Group A Guidelines:

- *Typical end use product of the active ingredient tested.* This criterion was met as a commercial product was used in the study.

- *End use product handled and applied using recommended equipment, application rates, and typical work practices.* This criterion was met as the equipment used in this study, ready-to-use bottles, was in conformity with the application method on the label. However, the application rate was determined by each subject's subjective determination.

- *For outdoor exposure monitoring at least five replicates at each of at least three sites for each job function with the exception of pilots should be monitored.* This criterion was met. A total of 15 replicates from different homes were analyzed from one geographical location (Indianapolis, Indiana).

- *For indoor exposure monitoring at least five replicates at each of at least three sites for each job function must be monitored.* This criterion is not applicable to this study.

- *Monitoring period is sufficient to collect measurable residues, but not excessive so that residue loss occurs.* The criterion was met.

- *Dermal and/or inhalation exposure must be monitored by validated methodologies. Biological monitoring is consistent with and supported by pharmacokinetic data accepted by the Agency.* This criterion was met (refer to "Data Summary" above).

- *Quantity of active ingredient handled and duration of monitoring period reported for each replicate.* This criterion was met as the amount of product applied was known and the time it took to apply the product at each location was recorded.

- *Clothing worn by each study participant and location of dosimeters reported.* This criterion was met (refer to "Clothing/Protective Clothing" above).

- *Quantitative level of detection is at least 1 $\mu g/cm^2$.* The limits of detection (LOD) and Limits of Quantitation (LOQ) for the sample matrices were as follows: glass filters (0.013 and 0.04 μg/filter, Chromosorb Tubes (0.013 and 0.04 μg/tube), coverall sections (1.3 and 4.0 μg/20 x 20 cm section), underwear sections (0.13 and 0.4 μg/20 x 20 cm section), handwash solution (0.7 and 2.0 μg/500 mL handwash), and urine (0.31 and 2.0 ng/mL).

- *Storage of samples consistent with storage stability data.* This criterion was met. Storage stability recoveries for coverall and underwear only were presented, however, field spikes were prepared for the other matrices and because they were handled under the same environmental conditions as the field samples would serve the same purpose, that is, testing for losses from sample handling, shipment and storage.

- *Efficiency of extraction in laboratory provided as mean plus minus one standard deviation. Lower 95% confidence limit is not less than 70% based on a minimum of seven replications per fortification level or prior Agency approval of extraction methodology provided.* The criterion was met. Laboratory recovery values were acceptable.

- *At least one field fortification sample per worker per monitoring period per fortification level for each matrix. At least one field blank per worker per monitoring period for each matrix.* Field recovery samples (weathered samples)

were collected for each of the sampling matrices except head patches. A single fortification level was analyzed for each matrix (duplicate samples).

Based on this review, this study meets the requirements contained in Series 875 Group A of the Pesticide Assessment Guidelines. These data are useful for risk assessment.

References

Nolan, R.J., Rick D.L, Freshour, N.L., Saunders J.H. 1984. Chlorpyrifos: Pharmacokinetics in Human Volunteers. Toxicol. Appl. Pharmacol. 73:8-15.

U.S. Environmental Protection Agency (USEPA). 1997. Exposure Factors Handbook. Volume Office of Research and Development. Washington, DC. EPA/600/P-95/002Fa

Table 1 Estimated Inhalation Dose for Homeowners Applying a Ready-to-Use Formulation

Volunteer	Number of Bottles Applied	Amount Applied		Chlorpyrifos Air Concentration (ug/m3) (a)	Monitoring Time (min)	Total Chlorpyrifos Inhaled (ug) (b)	Body Weight (kg)	Inhalation Exposure (ug/kg)
		Solution(g)	lbs ai					
AP01	5	3340	0.036	2.12	67	2.37	52.21	0.045
AP02	4	2779	0.03	1.21	62	1.25	59.02	0.021
AP03	4	2746	0.03	1.45	69	1.67	56.75	0.029
AP04	5	3316	0.036	2.03	67	2.27	68.1	0.033
AP05	5	3511	0.038	2.16	63	2.27	80.36	0.028
AP06	5	3471	0.037	3.3	53	2.92	52.66	0.055
AP07	2	1381	0.015	0.22	61	0.22	59.02	0.004
AP08	4	2754	0.03	1.71	63	1.80	63.56	0.028
AP09	5	3289	0.035	3.7	57	3.52	77.18	0.046
AP10	5	3460	0.037	1.15	59	1.13	56.75	0.020
AP11	5	3511	0.038	1.43	49	1.17	104.42	0.011
AP12	3	2095	0.023	1.49	65	1.61	77.18	0.021
AP13	5	3529	0.038	2	49	1.63	90.8	0.018
AP14	5	3525	0.038	1.53	57	1.45	93.07	0.016
AP15	5	3427	0.037	2.56	44	1.88	83.99	0.022
A. Mean		3076	0.033	1.87	59	1.81	1.87	0.03
std. Dev		607	0.006	0.83	7	0.77	33.29	0.01

(a) Mean of two monitors per subject.
(b) Assumes 1.0 m3/hour for light activities from USEPA Exposure Factors Handbook (1997).

Table 2. Total Dermal Exposure to Chlorpyrifos During Application of a Ready to Use Formulation

Rep No.	Body Weight	Torso (ug)	Arms (ug)	Legs (ug)	Penetration Factor	Nead/Neck (ug)	Hands (ug)	Total Dermal Exposure (ug) (a)	Estimated Amt. Dermally Absorbed (ug) (b)	Estimated Total Dermal Dose (ug/kg BW) c)
AP01	52.21	5.8	128.8	380.6	0.0366	7.1	282.4	438	13.14	0.25
AP02	59.02	1.9	12.9	288.7	0.0285	5.5	199	228	6.83	0.12
AP03	56.75	10	48.9	980.2	0.1176	22.8	496.8	694	20.81	0.37
AP04	68.1	2.8	106.8	404.8	0.0223	89	216.5	424	12.72	0.19
AP05	80.13	1.9	45.4	245.3	0.0185	18.9	126.7	197	5.92	0.07
AP06	52.66	17.6	801.7	2,498.50	0.027	62.2	207.7	1157	34.70	0.66
AP07	59.02	1.9	12.7	82.2	0.1149	2.4	28.7	55	1.65	0.03
AP08	63.56	1.9	14.3	337.2	0.0224	2.4	140.7	167	5.01	0.08
AP09	77.18	3.4	35.4	312.9	0.0641	12.6	123.1	195	5.84	0.08
AP10	56.75	1.9	57	90.6	0.0378	8.7	12.5	84	2.51	0.04
AP11	104.42	25.8	159.2	83.2	0.3767	2.4	40.7	259	7.78	0.07
AP12	74.91	1.9	83	1,556.60	0.0202	26.8	41.2	184	5.53	0.07
AP13	90.8	33.1	97.7	406.8	0.1765	14.2	2,334.40	2551	76.54	0.84
AP14	93.07	1.9	94.6	1,051.90	0.0109	37	87.4	232	6.97	0.07
AP15	83.99	17.5	607.5	8,709.90	0.0117	78	159.3	964	28.93	0.34
Mean	72	9	154	1162	0.072	26	300	522	16	0.22
Std Dev	16	10	231	2191	0.097	28	576	647	19	0.24
Percent		2	29	16		5	57			

(a) Total dermal exposure (non absorbed) = Torso + arms + head/neck+ (coverall legs, front and back * penetration factor).

(b) Estimated amount dermally absorbed (ug) = Total dermal exposure * 3% (dermal absorption).

C) Estimated amount dermally absorbed (ug) / body weight (kg).

Table 3. Summary of Absorbed Doses of Chlorpyrifos from Dosimetry and Biomonitoring Data for Homeowners that Apply a Ready to Use Formulation

Volunteer	Body Weight (kg)	Doses from Estimated Passive Dosimetry						Total Dose Estimated from Biomonitoring (ug/kg)			
		Total Dermal Exposure (ug) (a)	Estimated Amt. Dermally Absorbed (ug) (b)	Estimated Total Absorbed Dermal Dose (ug/kg BW) (c)	Total Dermal Exposure (ug/kg)	Inhalation Dose (ug/kg) (d)	Total Absorbed Dose (ug/kg) (e)	Mean Background TCP	Mean Background Chlorpyrifos (f)	Total Background Corrected TCP	Total Chlorpyrifos Exposure (g)
AP01	52.21	438	13.14	0.25	8.4	0.045	0.30	0.1237	0.30	0	0.00
AP02	59.02	228	6.83	0.12	3.9	0.021	0.14	0.0478	0.12	0.0062	0.02
AP03	56.75	694	20.81	0.37	12.2	0.029	0.40	0.046	0.11	0.1223	0.35
AP04	68.1	424	12.72	0.19	6.2	0.033	0.22	0.0256	0.06	0.1491	0.43
AP05	80.13	197	5.92	0.07	2.5	0.028	0.10	0.0288	0.07	0.109	0.32
AP06	52.66	1157	34.70	0.66	22.0	0.055	0.71	0.066	0.16	0.5457	1.58
AP07	59.02	55	1.65	0.03	0.9	0.004	0.03	0.0391	0.10	0.2364	0.68
AP08	63.56	167	5.01	0.08	2.6	0.028	0.11	0.0812	0.20	0.0501	0.14
AP09	77.18	195	5.84	0.08	2.5	0.046	0.12	0.0389	0.10	0.1128	0.33
AP10	56.75	84	2.51	0.04	1.5	0.02	0.06	0.0388	0.10	0.0241	0.07
AP11	104.42	259	7.78	0.07	2.5	0.011	0.09	0.02	0.05	0.0191	0.06
AP12	74.91	184	5.53	0.07	2.5	0.021	0.09	0.0321	0.08	0.1187	0.34
AP13	90.8	2551	76.54	0.84	28.1	0.018	0.86	0.0688	0.17	0.3985	1.15
AP14	93.07	232	6.97	0.07	2.5	0.016	0.09	0.0241	0.06	0.6575	1.90
AP15	83.99	964	28.93	0.34	11.5	0.022	0.37	0.0548	0.13	0.0039	0.01
Arth. Mean		522	16	0.22	7.31	0.03	0.25	0.05	0.12	0.17	0.49
Std Dev		647	19	0.24	8.09	0.01	0.25	0.03	0.07	0.21	0.59
Geomean (h)											0.24

(a) Total dermal exposure (non absorbed) = Torso + arms + head/neck+ (coverall legs, front and back * penetration factor).

(b) Estimated amount dermally absorbed (ug) = Total dermal exposure * 3% (dermal absorption).

(c) Estimated amount dermally absorbed (ug) / body weight (kg).

(d) See Table 1.

(e) Sum of total absorbed dermal and inhalation doses.

(f) Chlorpyrifos background exposure (ug/kg) = [3,5,6-TCP pre-study * 350.6/198 (molecular weight ratios for chlorpyrifos and TCP) / 0.72 (fraction of chlorpyrifos excreted in the urine as TCP]

(g) Chlorpyrifos exposure (ug/kg) = [3,5,6-TCP excreted over background * 350.6/198 (molecular weight ratios for chlorpyrifos and TCP) / 0.6124 (fraction of chlorpyrifos excreted in the urine as TCP] over 5 days (I.e., 85% of 0.72, see Appendix A). Data are log normally distributed based on the Shapiro WIlks test.

'(h) The geometric mean is calculated without AP01, whose exposure is not quantifiable because of background exposure of 0.3 ug/kg.. Data are log normally distributed based on the

Shapiro WIlks test.

APPENDIX A

Pharmacokinetic Model Used by DowAgroSciences to Estimate the Amount of Chlorpyrifos Absorbed After Exposure

$$Xu(t) = Ka * fXo\ [1/Ka + Exp\ (-Kt)/(K-Ka) - K * exp\ (-Ka * t) / (Ka*(K-Ka))]$$

Where:

t = time in hours
K = 0.0258 = rate constant for elimination, per hr
Ka = 0.0308 = rate constant for absorption, per hr
f = 0.72 = fraction of absorbed dose excreted as 3,5,6-TCP

Xo = 1

Days	*Hours Post Dosing*	*Ka*f*	*1/Ka*	*exp(-Kt)/ (K-Ka)*	*-K*exp(-Ka*t)/ Ka*(K-Ka)*	*Cum. Exc. Xut(t)*	*Int Excr. Xut(t)- Xut(t-1)*
	0	*0.0222*	*32.47*	*-200.00*	*167.53*	*0.0000*	*0.0000*
	12	*0.0222*	*32.47*	*-146.75*	*115.77*	*0.0331*	*0.0331*
1	*24*	*0.0222*	*32.47*	*-107.67*	*80.00*	*0.1064*	*0.0733*
	36	*0.0222*	*32.47*	*-79.01*	*55.28*	*0.1941*	*0.0877*
2	*48*	*0.0222*	*32.47*	*-57.97*	*38.20*	*0.2820*	*0.0879*
	60	*0.0222*	*32.47*	*-42.53*	*26.40*	*0.3626*	*0.0806*
3	*72*	*0.0222*	*32.47*	*-31.21*	*18.24*	*0.4329*	*0.0703*
	84	*0.0222*	*32.47*	*-22.90*	*12.60*	*0.4922*	*0.0593*
4	*96*	*0.0222*	*32.47*	*-16.80*	*8.71*	*0.5412*	*0.0490*
	108	*0.0222*	*32.47*	*-12.33*	*6.02*	*0.5808*	*0.0396*
5	*120*	*0.0222*	*32.47*	*-9.05*	*4.16*	*0.6124*	*0.0316*
	132	*0.0222*	*32.47*	*-6.64*	*2.87*	*0.6372*	*0.0248*
	133	0.0222	32.47	-6.47	2.79	0.6392	0.0020
6	*144*	*0.0222*	*32.47*	*-4.87*	*1.99*	*0.6569*	*0.0197*
	156	*0.0222*	*32.47*	*-3.57*	*1.37*	*0.6719*	*0.0150*
7	*168*	*0.0222*	*32.47*	*-2.62*	*0.95*	*0.6837*	*0.0118*
	180	*0.0222*	*32.47*	*-1.92*	*0.66*	*0.6928*	*0.0091*
8	*192*	*0.0222*	*32.47*	*-1.41*	*0.45*	*0.6995*	*0.0067*
	204	*0.0222*	*32.47*	*-1.04*	*0.31*	*0.7047*	*0.0052*
9	*216*	*0.0222*	*32.47*	*-0.76*	*0.22*	*0.7088*	*0.0041*
	228	*0.0222*	*32.47*	*-0.56*	*0.15*	*0.7118*	*0.0030*
10	*240*	*0.0222*	*32.47*	*-0.41*	*0.10*	*0.7140*	*0.0022*

Values used for calculating chlorpyrifos exposure

0.85 = 0.6124 (amount excreted in 5 days)/ 0.72 (total amount of chlorpyrifos excreted in the urine as TCP)